TECHNICAL BULLETIN

SUBJECT: Application of Hermetic Compressors to Refrigeration Capillary Systems.

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Introduction.

The purpose of this technical bulletin is to provide guidelines for the application of hermetic compressors to refrigeration systems that use capillary tubes as the refrigerant control method. It is not intended for use in capillary air conditioning applications or refrigeration systems utilising TX valves. The life and reliability of hermetic compressors is directly related to how well the overall refrigeration system is balanced and tuned. By applying the guidelines outlined in this Bulletin and testing the system at its extremes of operation, you can be assured many years of reliable operation of the compressor and related ancillary items.

This Bulletin specifically covers issues related to the compressor and the refrigeration circuit. The guidelines aim to ensure that the compressor operates with adequate lubrication at all times, is within its temperature limits and does not cycle on and off excessively. Airflow and distribution within the cabinet and also through the condenser coil can have a dramatic effect on the life of the refrigeration system. This Bulletin does not cover this aspect but it is assumed that there is adequate airflow and distribution throughout the cabinet and that no recirculation occurs through the condenser coil.

Heatcraft also recommends the use of R134a refrigerant for typical medium temperature capillary applications such as upright drink cabinets' etc. Refrigerants such as R404A can be used but are problematic in that it is difficult to tune the refrigeration system to work within the following guidelines for all conditions likely to be encountered.

Capillary selection and application.

The capillary should be selected and applied taking into consideration the following:

- The capillary length should be between 2 and 5 metres to allow satisfactory control across the ambient range. Capillary lengths below 2 metres can cause unstable flow through the capillary.

- Suction heat exchange should be utilised to reduce the level of flash gas in the capillary. Excessive flash gas in the capillary has the effect of increasing the restriction in the capillary and reducing the flow.

- The drier should be mounted in a manner that prevents liquid backup in the condenser. Liquid back up in the condenser increases the operating condensing pressure, reducing compressor capacity.

- The drier should be mounted in a manner that ensures a liquid seal at the entrance to the capillary. If there is not a full liquid seal at the entrance to the capillary. This can cause sporadic operation of the refrigeration system.

- At high ambient conditions the capillary selected should allow a maximum of 3k sub cooling in the condenser. Excessive sub cooling is an indication of a "too restrictive"

capillary. Excessive sub cooling is caused by liquid backing up in the condenser, increasing the operating condensing pressure and reducing compressor capacity.

Suction superheat.

The suction superheat should be determined by the following:

- The suction temperature measured 150mm from the compressor housing on the suction line should be 10 to 15k above the evaporator temperature at “high ambient low load” conditions.
- Applying “Compressor Discharge Temperature” guidelines.
- Applying “Compressor Oil Temperature” guidelines.

Compressor discharge temperature.

- Under “high load, high ambient” conditions compressor discharge temperature measured 150mm from the compressor housing should not exceed 120°C for refrigerants R22 and R404a. This will prevent temperatures at the compressor valve plate from exceeding the oil manufacturer guidelines causing a breakdown of the oil. Breakdown of the oil causes coking on the valve reeds and also cause the oil to lose its lubricating properties. Generally excessive discharge temperature are not experienced when using R134a.

Compressor oil temperature.

The compressor oil temperature should be maintained above the following minimum temperatures:

- At 10°C ambient the minimum oil temperature should be 30°C.
- At 21°C ambient the minimum oil temperature should be 41°C.
- At 32°C ambient the minimum oil temperature should be 52°C.
- At 43°C ambient the minimum oil temperature should be 63°C.

The oil temperature is measured by using a thermocouple attached to the compressor housing, it should be as low as possible and within 20mm of the housing bottom.
If the oil temperature falls below the stated values it indicates that liquid refrigerant is being returned to the compressor. Liquid refrigerant dilutes the oil in the compressor and will cause premature bearing wear.

Condenser volume / refrigerant charge ratio.

- The condenser volume should be 1.3 times greater than the refrigerant charge to allow the entire refrigerant charge to be held in the condenser. This protects the compressor and refrigeration system should a blockage in the capillary occur.

Evaporator / condenser volume ratio.

- The evaporator to condenser volume ratio should be 1.4 or higher to allow a satisfactory system balance across the design ambient range ie: the evaporator volume should be 40% greater than the volume of the condenser. If the volume ratio is below 1.4 then a satisfactory system balance cannot be obtained across the operating ambient range.

Accumulator sizing.

- The accumulator volume should be determined by charging the system at the highest ambient and lowest load condition until the evaporator reaches a flooded state with no superheat. The unit should then be operated at the lowest ambient condition and refrigerant added until the evaporator is flooded. The difference in these two charge levels is used to determine the accumulator volume.

Compressor percentage run times.

The compressor selection should be based on the following duty cycle on a fully loaded cabinet:

- At 10°C ambient the compressor should operate 25% +/-5% of the time.
- At 21°C ambient the compressor should operate 50% +/- 5% of the time.
- At 32°C ambient the compressor should operate 75% +/- 5% of the time.
- At 43°C ambient the compressor should operate 95% +/- 5% of the time.

Compressor starts per hour.

To ensure long life of the compressor and associated electrical components the following is recommended:

- The recommended maximum number of compressor starts per hour is 4 at an ambient of 21°C. The ideal number of compressor starts per hour at this ambient would be 2.

It should be noted that on capillary systems there is a slight flood back on start up following an off cycle. This is due to the capillary continuing to feed liquid refrigerant from the condenser during the off cycle. Excessive number of compressor starts per hour can cause dilution of the oil and insufficient oil being present on the bearing surfaces.

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Compressors that are oversized for a system and/or have too many starts per hour will have very short run times. With short run times it is unlikely that the compressor would achieve its optimum operating temperature and would not meet the "Compressor Oil Temperature" guidelines.

Compressor balance time.

- In the compressor off cycle, the capillary should be selected to allow a balance time of approximately 2-3 minutes. A longer balance time indicates a restrictive capillary causing excessive liquid back up in the condenser.

System balanced pressure.

The maximum balanced pressure for a system soaked out at 43°C ambient should be:

- R22 = 1410 kPa
- R404a = 1410 kPa
- R134a = 724 kPa

Condenser TD.

The maximum condenser TD for satisfactory performance on capillary systems should be:

- At 32°C ambient maximum TD should be 10k
- At 43°C ambient maximum TD should be 10k

Increased condenser TD's can lead to reduction in refrigeration capacity; increases in discharge temperature, power consumption and reduction in refrigeration capacity.

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